compare in our annals with anæsthesia—we must rejoice at what has been done by our art and science for humanity. In his lectures on the progress of anatomy and surgery during the present century, the distinguished surgeon just quoted says:—

> "It is the boast of those who live in the nineteenth century, that progress in all that pertains to civilization has been greater than in any similar period in history. I cannot venture to claim for surgery the world-wide impression that has been made by steam, by electricity, by engineering, or by mechanics. Yet our art and science have not stood still. If there have been changes and reforms in our laws and civil institutions for the improvement of our social atmosphere—and who can entertain a doubt on the subject?—we may point to our changes, our reforms, our improvements also."

Fergusson might have spoken less cautiously and with more enthusiasm. We may well believe that the improvements in our profession have been far greater, that by them the pains and sufferings of our fellow-men have had more relief than by any changes made in laws and civil institutions.

The changes that have taken place in this nineteenth century are, in some respects, greater than ever took place before in all the past centuries known in history. When this century began, the flash of the lightning did not instantaneously reveal, at any desired moment, what was transpiring in the most distant regions, nor did the forces of vapour give wings to the wheels of cars and the sails of ships. When after the signing of the Treaty of Peace with Great Britain in 1814, the Judge of the Eastern District of Pennsylvania left Lancaster to hold court in the adjoining county of Lebanon, he communicated to the delighted inhabitants the joyful news known in Lancaster two days before. In fact when men then travelled on land there was but little difference between their mode of locomotion and that of Father Abraham, and on sea they were dragged by oars and pushed by the wind, as was Jason when he sought the Golden Fleece. And so in surgery, since the days of Bichat, the progress is greater than that made before since the days of Hippocrates.

Our art and science have not only "not stood still," but they have advanced, and are advancing *pari passu* with the others. And of this advance we do not care to give a better example than the one afforded to us by the authors of the work we have been so pleased to point out to our readers.

W. F. A.

ART. XX.—*A Text-Book of Physiology.* By M. FOSTER, M.A., M.D., F.R.S., Prælector of Physiology and Fellow of Trinity College, Cambridge. 8vo. pp. 559. London: Macmillan & Co., 1877.

THE "publishing mania," which seems to have lately taken possession of our physiologists, resulting in the appearance, within the past twenty months, of at least a "baker's dozen" of new or revised physiological textbooks, threatens to speedily *glut* the physiological market.

When Dr. Mayer, in 1842, first pointed out the physiological relations of the brilliant discoveries of Joule, Grove, and Helmholtz in the domain of physics, physiology entered upon a new era. We may, perhaps, correctly christen it the era of *positiveness*, in which the physical methods of investigation are applied to the interpretation of vital phenomena.

Animated by this new spirit we have, among recent works on physiology, three text-books, representing as many nationalities, which may be considered as exponents of the new doctrine—Hermann's Elements, by far the most radical of the three, Beaunis' Nouveaux Elements, and Dr. Foster's Text-Book of Physiology, which is the subject of this notice.

In view of the many strong rivals already in the field a new candidate for professional favour must have some marked excellences to secure for it a favourable reception. In our opinion Dr. Foster's Text-Book possesses such excellences, and while we shall have occasion to notice some defects, we predict for it a flattering future.

Dr. Foster is already favourably known to the profession as one of the authors of the best manual on embryology in the language, and also as joint author of a recent work on Elementary Physiology.

From the preface we learn that the author has—

> "Made no attempt to give a comprehensive account of all the statements, conflicting or accordant, which have been made, or of the opinions which have been held concerning the phenomena exhibited by animal bodies. I have rather striven to explain, in as clear and straightforward a manner as I could, the main facts and fundamental principles of physiological science. The student before whom things both new and old are tumbled out of the physiological treasury, without adequate critical appreciation of their respective values, is simply bewildered without being taught; and, finding that the labours of the Physiological Laboratory at Hinauf seem to be chiefly directed to contradicting the results of the laboratory at Hinab, very naturally concludes that he had better pay attention to neither."

While we have here no claim of original work, the author shows in the discussion of every subject that he has fully matured views of his own, and the general method and plan of the work is such as will give it decided character.

There are three prime desiderata in a text-book: brevity, completeness, and clearness, all of which Dr. Foster seems to have kept in mind in the preparation of the volume before us.

However, when we recall the fact that physiology, with its collaterals has grown into proportions so immense that our text-books almost of necessity assume encyclopediac dimensions, we are inclined to consider somewhat critically the method of condensation adopted. It has not been attained wholly by concise expression, for our author is at times quite rhetorical and leads one through his vivid word painting to almost forget the knotty questions under discussion. The physiological anatomy of the various structures and organs of the body is almost wholly ignored, and in the preface we read, "In the presence of Quain's Anatomy, there is no need for a physiological treatise to repeat imperfectly what is there said so well." But when we consider the immense number of facts with which the student is compelled to store his brain; the shortness of his student-life, and the rapidity with which he is necessarily hurried from one branch of medicine to another, we cannot but feel that a brief *resumê* of the physiological anatomy of an organ should accompany the study of its function. Function cannot be intelligently separated from structure.

We must also take issue with the author in the estimate he places upon diagrams and illustrations. "I have moreover given neither figures nor elaborate descriptions of physiological instruments and apparatus. These must be seen, not read about; the student can learn more by five minutes' inspection of a piece of apparatus, especially one at work, than by hours of study of even the most finished and expensive pictures, and most detailed verbal descriptions." It occurs to us that the value of correct plates, in illustration of the text, is too highly attested in medical literature to admit of discussion. They serve to refresh the memory of those who have seen the original, and to those who have not had such an opportunity, which number embraces the large majority of medical students when they begin the study of physiology, they are almost invaluable.

We were much disappointed on turning to Book IV., which treats of "The Tissues and Mechanism of Reproduction," to find this important subject summarily dismissed in about a dozen pages. The profession had reason to expect this subject to be exceptionally well-treated, not slurred over, for no one is better qualified to speak *ex cathedra* than the distinguished author. His work, already published, in connection with Dr. Balfour, on the development of the fowl, is an important contribution to the study of biology, and the profession eagerly awaits the appearance of the second part which will trace the process of development in the mammalia.

The condensed summaries which illustrate the text in almost every section is a most valuable feature of Dr. Foster's work, and one which will recommend itself to the student.

Another commendable feature may be found in the historical accounts of each of the great subjects of which the volume treats, together with appropriate references to the classical authorities. These histories, though necessarily brief, have a wholesome effect in giving the student a more philosophical idea of the subject, than he would otherwise obtain.

The volume before us contains 559 large octavo pages, and is divided into four books, which treat respectively—.
I.—Blood. The Tissues of Movement. The Vascular Mechanism. II.—The Tissues of Chemical Action, with their Respective Mechanisms. Nutrition. III.—The Central Nervous System and its Instruments. IV.—The Tissues and Mechanism of Reproduction. To which is added an appendix of fifty-three pages, "On the Chemical Basis of the Animal Body," in which is given a brief but carefully prepared account of the various chemical constituents of the organism.

The introductory chapter very appropriately portrays the physiological life of the humble little amœba, in which the vital problems find their simplest expression. The undifferentiated protoplasm of which its body is composed possesses the following fundamental properties: (1) It is contractile. (2) Irritable and automatic. (3) Receptive and assimilative. (4) Metabolic and secretory. (5) Respiratory. (6) Reproductive.

> "Such are the fundamental vital qualities of the protoplasm of an amœba; all the facts of the life of an amœba are manifestations of these protoplasmic qualities in varied sequence and subordination. The higher animals, we learn from morphological studies, are in reality groups of amœbæ peculiarly associated together. All the physiological phenomena of the higher animals are similarly the results of these fundamental qualities of protoplasm peculiarly associated together. The dominant principle of this association is the physiological division of labour, corresponding to the morphological differentiation of structure. . . . In the evolution of living beings through past times, it has come about that in the higher animals (and plants) certain groups of the constituent amœbiform units or cells have, in company with a change of structure, been set apart for the manifestation of certain only of the fundamental properties of protoplasm, to the exclusion, or at least to the complete subordination of the other properties."

The complex body of the higher animals may then be considered as a compound of so many tissues, each tissue corresponding to one of the fun damental qualities of protoplasm, to the development of which it is specially devoted by a division of labor. These separate tissues, with their individual characters, are, however, but parts of one body, and in order that they may become true members of the body politic, working harmoniously together, need certain co-ordinating bonds. These bonds are primarily of two kinds: (1) a vascular bond for the distribution and interchange of material; and (2) an irritable bond, along the strands of which various impulses travel for the regulation of the energy of distant spots in the organism. Still other secondary mechanisms make their appearance as we creep up the ladder of life—as, for example, a special motor mechanism, and a "central nervous mechanism of complex structure and complex function, the complexity of which is not due primarily to any mechanical arrangement of its parts, but to the further differentiation of that fundamental quality of irritability and spontaneity which belongs to all irritable tissues and to all native protoplasm."

This interesting chapter, which we have imperfectly sketched above, furnishes the basis of the classification adopted by the author, and foreshadows some of the distinctive features of the work.

Chapter I. opens with a discussion of the Blood, which is treated of under the following heads: (1) General Chemical Composition. (2) Phenomenon of Coagulation. (3) History of Corpuscles. (4) Quantity in the Body.

The phenomena of coagulation are very clearly presented, and this discussion is one of the interesting features of the chapter. The author accepts the theory of Schmidt as to the formation of fibrin, and concludes that in the present condition of our knowledge the exact nature of the process by which the presence of the three factors (fibrinoplastin, fibrinogen, and fibrin-ferment) leads to the formation of fibrin, cannot be defined more closely than by the phrase "*interaction.*" This explanation, to say the least, is not very definite.

Reserving, as the author does, the consideration of the changes which the blood undergoes in the various tissues until those tissues are under discussion, we are compelled to turn to the chapter on Respiration for a history of the gases of the blood, and for a very excellent and full exposition of the properties of hæmoglobin.

Chapter III. contains a valuable summary of the fundamental properties of nervous tissues. We are glad to see this subject introduced thus early in the book, for it will certainly enable the student to follow more intelligently the various phenomena to be presently described. Beginning with the simple form in which the nerve, as a thin strand of irritable protoplasm, shows itself in the hydra, the development of the typical nervous system is briefly traced.

We are here told that the fundamental and primary differentiation of the work of a central nervous system is into automatic and reflex operations, which are manifested by the brain and spinal cord, and less certainly by the sporadic ganglia.

Dr. Foster does not endorse the view that the spinal cord is a series of automatic centres, and even expresses grave doubts as to whether the spinal cord possesses any automatic functions whatever. In fact, he is inclined to look upon the exhibition of automatism as strictly a function of brain tissue.

"In the sporadic ganglia the evidence of automatic action seems more clear, and yet is by no means absolutely decisive. The beat of the heart is a typical automatic action; and since the heart will continue to beat for some time when isolated from the rest of the body (that of a cold-blooded animal continuing to beat for hours or even days), its automatism must lie in its own structures. When, however, we come to discuss the beat of the heart in detail, we shall find that it is still an open question whether the automatism is confined to the ganglia (either of the sinus venosus, auricles, or auriculo-ventricular boundary), or shared in by the muscular tissue; whether, in fact, the automatism is a muscular automatism, like that of a ciliated cell, or the automatism of a differentiated nerve-cell. And yet the heart is the case where the automatism of the ganglia seems clearest."

It may be proper to say in this connection, that Dr. Foster, as we learn from a foot-note in the introductory chapter, does not use the term automatic in the narrow sense suggested by many, but "as denoting an action of the body, the causes of which appear to lie in the body itself."

Passing next to the consideration of the general principles which underlie reflex action, it is stated that the chief seats of reflex activity, in the vertebrata, are the brain and spinal cord, the latter may indeed be considered as a multitude of reflex centres.

The evidence yet obtainable is insufficient to prove that the nerve-cells of the sporadic ganglia possess reflex functions. We have positive evidence to the contrary in the case of the ganglia on the posterior roots of the spinal nerves; and of the larger ganglia, indications of reflex activity are present alone in the submaxillary, and these indications are not beyond dispute.

The chapter concludes with the following statement of the fundamental properties of nervous tissues:—

"Nerve-fibres are concerned in the propagation only, not in the origination or transformation of nervous impulses. As far as is at present known, impulses are propagated in the same manner along both sensory and motor nerves. Sensory impulses differ from motor impulses, inasmuch as the former are generated in sensory organs and pass up to the central nervous cells, while the latter pass from the central nervous cells to the muscles, or to some other peripheral organs. The operations of the nerve-cells are either automatic or reflex. In both an automatic and a reflex action, the diversity and the co-ordination of the impulses is determined by the condition of the nerve-cells. During the passage of an impulse along a nerve-fibre, there is no augmentation of energy; in passing through a nerve-cell, the augmentation may be and generally is most considerable. When afferent impulses reach a centre already in action, the activity of that centre may, according to circumstances, be either depressed or exalted, may be inhibited or augmented."

Chapter IV. on the Vascular Mechanism is one of the best chapters in the book. Two things are pointed out as necessary to enable the blood to become a satisfactory medium of communication between the different tissues of the body. First, the flow of blood must have a certain rapidity and constancy; and, second, this flow must be susceptible of general and local modifications. The former is almost wholly a physical problem, while the latter, depending upon the intervention of the nervous system, is essentially a physiological question.

The study of the physical phenomena of the circulation is introduced with a brief statement of the general facts pertaining to the capillary, arterial, and venous systems. The hydraulic principles of the circulation are clearly stated, and the chief mechanical factors are shown to be the force and frequency of the heart-beat, the peripheral resistance, and the elasticity of the arterial walls.

In speaking of the heart-sounds, Dr. Foster accepts the customary explanation of the second sound, but recognizes in the correct interpretation of the first sound many difficulties, which are briefly stated in the following quotation:—

> "It is heard distinctly when the chest-walls are removed. The cardiac impulse can, therefore, have little to do with it. In point of time, and in the position in which it may be heard to the greatest advantage, it corresponds to the closure of the auriculo-ventricular valves. In point of character it is not such a sound as one would expect from the vibration of membranous structures, but has, on the contrary, many of the characters of a muscular sound. In favour of its being a valvular sound, may be urged the fact that it is obscured, altered, replaced by murmurs, when the tricuspid or mitral valves are diseased: and Halford found that clamping the great veins stopped the sound though the beat continued. On the other hand, Ludwig and Dogiel heard the sound distinctly in a bloodless dog's heart, in which there was no fluid to render the valves tense and set them vibrating. But there is a great difficulty in regarding it as a muscular sound, for a muscular sound is the result of a tetanic contraction, the height of the note produced varying with the number per minute of the simple contractions which go to make up the tetanus. A simple contraction or spasm cannot possibly produce a musical sound, such as is the cardiac sound. The beat of the heart is a comparatively slow, long-continued single spasm, and not a tetanic contraction. The rheoscopic frog answers to the negative variation, accompanying each ventricular systole by a single spasm, not by a tetanus. (Recent researches, however, have rendered it doubtful whether the absence of tetanus in a rheoscopic muscle can be entirely trusted as proving that the contraction which is being tested is not tetanic in nature.) In its long latent period, and in all its characters, the heart's beat bears the stamp of being a single spasm. If so, it cannot give rise to a note. Moreover, in cases of hypertrophy, where the muscular element and action is increased, the sound, so far from being increased, is impaired. . . . The difficulties are rather increased than met by supposing that the sound is at once both muscular and valvular in origin."

We are surprised to find here no reference to Prof. Ceradini, who has so thoroughly studied this question.

The section which follows with the discussion of the pulse is decidedly good, and is enriched with numerous sphygmographic tracings. We are glad to see brought out clearly the distinction between the pulse-wave and the movement of the blood itself. This distinction is far too generally ignored by our physiological text-books. The pulse-wave, it is here stated, travels over the moving blood somewhat as a rapidly moving natural wave travels along a sluggishly flowing river.

Of the secondary waves on the natural pulse curve, Dr. Foster calls special attention to the dicrotic wave, occurring towards the end of the descent, and the pre-dicrotic wave, which immediately precedes it. These are both waves of oscillation, but while the latter is a wave of pure oscillation, the dicrotic needs some especial event to produce it, which event is considered to be the closure of the aortic valves. In thus ascribing a central cause for the dicrotic wave, the author differs from Burdon Sanderson and others, who trace it to a sort of rebound from the periphery.

This brings us to the consideration of the vital phenomena of the circulation. If the physical facts above sketched were the only ones connected with the blood's circulation, "the canon of the life of every part for the whole period of its existence would be furnished by the in-born diameter of its bloodvessels, and by the unvarying motive power of the heart." Such a condition, however, does not exist in living beings. One of the most prominent features of the living mechanism is the power of adapting itself to the ever-varying external and internal circumstances. This adaptability is secured by, 1st, changes in the heart's beat, and, 2d, changes in the peripheral resistance due to variations in the calibre of the minute arteries: to which are added, as subsidiary modifying events, 3d, "changes in the peripheral resistance of the capillaries due to influences arising out of the as yet obscure relations existing between the blood within, and the tissue without the thin permeable capillary walls, and depending on the vital conditions of the one or the other;" and 4th, changes in the quantity of blood in circulation.

The modification of the heart beats through the influence of the vagi and accelerator nerves is very fully described. The effects of the various poisons (atropia, urari, muscarin, jaborandi) on vagus inhibition are treated of in detail.

Section V. treating of the changes in the calibre of the minute arteries, contains the most lucid account of vaso-motor physiology to be found in any text-book with which we are familiar. We infer the author accepts the localization of the vaso-motor centre indicated by Owsjannikow, since no other researches excepting those of Cyon are mentioned in this connection.

In concluding his remarks upon the general vaso-motor centre, Dr. Foster writes:—

> "We have said enough to show that the calibre of the small arteries, which by determining the peripheral resistance forms one important factor regulating the flow of blood, is subject to influences proceeding from all parts of the body, the influences reaching the arteries in a reflex manner by means of the vaso-motor centre, the afferent impulses being for the most part carried by ordinary sensory nerves, while the efferent impulses pass along special vaso-motor nerves, which, though the vaso-motor centre lies in the medulla oblongata, have a great tendency to run in sympathetic tracts.
>
> "Further, since the effects may be either local or general, the local being frequently opposite to the general, there is fair reason for assuming that the vaso-motor centre is a multiple centre, composed of minor centres governing particular vascular areas, so associated together that they may, according to circumstances, act either together or apart."

In addition to this general centre, Dr. Foster holds that there are phenomena which compel us to admit the existence of local peripheral vaso-motor centres, and proceeds to point out such phenomena in the vascular supply of the penis and the submaxillary gland.

Book I. closes with an admirable and most valuable summary of the mutual relations and the co-ordination of the vascular factors, which our limited space alone prevents us quoting in full.

The succeeding one hundred and eighty pages, comprising Book II., are devoted to the discussion of the important subjects of Digestion, Respiration, Secretion, and Nutrition. The tissues and mechanism of digestion are described under the following four heads: The properties of the digestive juices; the nature and regulative mechanism of their secretion; muscular mechanisms of digestion, and the changes which the food undergoes in the alimentary canal.

The physical and chemical peculiarities of the various digestive fluids are briefly but clearly presented. The author, however, asserts much more positively than the facts seem to justify, that hydrochloric acid is the free acid of the gastric juice. The only proof he brings forward is the assertion of Bidder and Schmidt, that the amount of hydrochloric acid in the gastric juice is more than can be neutralized by the bases present. Granting the fact (which is by no means proven, or even generally admitted), the probability is very strong that the excess of chlorine does not exist as free acid, but is united with organic matter. Certainly, the researches of Dr. F. G. Smith on St. Martin, as well as his more recent observations (see last American edition of Carpenter's Physiology), render it highly probable that *lactic acid* is the free acid of the gastric juice, not a mere *secondary product* as is so confidently stated in the text.

Dr. Foster states very positively that "pepsin is not a proteid," and claims that the manifestation of peptic power is at present our only test of its presence. The following statement will hardly go unchallenged in the face of the accumulated evidence, that there can be no true gastric digestion in the absence of pepsin.

> "Peptones closely resembling, if not identical, with those obtained by gastric digestion may be obtained by the action of strong acids, by the prolonged action of dilute acids at high temperatures, or simply by digestion with super-heated water in a Papin's digester. The *role* of pepsin therefore is only to facilitate a change which may be effected without it. Since, in the act of digestion, the pepsin itself is not exhausted, it is clear that the energy which is spent in the conversion of the proteid into peptone does not come from the ferment."

The next section, which endeavours to explain how the various epithelium cells manufacture their various digestive fluids out of a common pabulum, introduces us at once to some of the most interesting and intricate problems in physiology. This section, written in the author's happiest style, is well worth the student's careful attention.

The question which meets us at the very threshold of our inquiry is, does the epithelium merely serve as a filter, draining off from the blood the ready-formed constituents of its secretions, or does the cell, through a subtle chemistry peculiar to itself, manufacture out of the common pabulum of all protoplasm the characteristic fluid?

Preliminary to this question, the author discusses the influence of the nervous system over the secreting cell, limiting himself chiefly to the submaxillary gland, which has been so elaborately studied by various physiologists. After detailing with some minuteness the effects which follow division and stimulation of the sympathetic and chorda tympani, he concludes that the flow of saliva is a reflex action, the efferent impulses of which, through the chorda tympani, directly affect the secreting cells, and while the vascular phenomena may assist, they are by no means the direct cause of the flow.

This brings us to the second problem, *i. e.*, what is the exact nature of the activity thus called forth? In the discussion which follows, Dr. Foster chooses for his text the pancreatic juice, the properties of which have been so thoroughly studied by Bernard and Heidenhain. After emphasizing the fact that the glycerine extract, made from a pancreas freshly removed from the body, does not possess active proteolytic qualities, but that these qualities may be secured by appropriate manipulation, it is stated:—

> "These facts show that a pancreas taken fresh from the body, even during full digestion, *contains but little ready made ferment*, though there is present in it a body which by some kind of decomposition *gives birth to the ferment*. They further show that though the presence of an alkali is essential to proteolytic action of the actual ferment, the formation of the ferment out of the body in question is favoured by the presence of an acid. To this body, this mother of the ferment, Heidenhain has given the name of *Zymogen*. It has not at present been satisfactorily isolated.
>
> "Hence, in judging of the functional activity of the pancreas under various circumstances, we must look not to the ready-made ferment, but to the ferment-

> giving zymogen. . . . . Evidently, so far from the proteolytic ferment being simply drained off from the blood, in the first place the actual ferment is formed in the pancreas out of the zymogen, and in the second place the zymogen of the inner granular zone is formed in the cell itself out of the homogeneous outer zone. We have in fact two distinct processes to deal with: (1) The manufacture of zymogen; that is part of the growth or nutrition of the cell, and is slow and continued; (2) the splitting up or conversion of the zymogen into the proteolytic ferment; this is the actual act of secreting, and is rapid and intermittent; this is the form of activity which can be called forth by nervous impulses, the form of activity which is comparable to a muscular contraction. The thought at once suggests itself that the appearance of an acid in the protoplasm of the cell under circumstances similar to those which give rise to the acid formed during muscular contraction, might be the immediate cause of the zymogen becoming converted into ferment.
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> "In the case, then, of the proteolytic ferment of the pancreas, we have striking proof that the process of secretion, both in its preparatory and executive stages, is a laborious, active, manufacturing function of the cell, and not simply a passive, selective, filtering function. How far this is also true of the other ferments of the pancreas, and of the active constituents of the other digestive juices, cannot at present be authoritatively affirmed, but we have, both in the case of the stomach and of the salivary glands, facts pointing very distinctly in that direction."

Respiration, which forms the subject of Chapter II., is described in the same clear and concise manner which we have found to characterize other portions of the work. We are compelled to omit an analysis of its contents.

In Chapter V., under the euphonious heading, "The Metabolic Phenomena of the Body," we have an attempt "to connect together the food and the waste products, to trace out as far as we are able the various steps by which the one is transformed into the other, and to inquire into the manner in which the energy set free in this transformation is distributed and made use of."

We are first presented with a very carefully prepared history of glycogen, the formation of which in the hepatic cells is the best known example of metabolic activity. The old question is here again revived as to whether the blood of the hepatic or portal veins contains the larger portion of sugar. The author, notwithstanding the researches of Pavy, Tscherinoff, and others, is inclined, in the conflicting state of the evidence, to look with favour upon the old opinion of Bernard, that the liver does normally discharge a certain quantity of sugar into the hepatic vein. However, in view of the liability of error in the quantitive determination of sugar in a specimen of blood, he very wisely concludes that some other method will be necessary to settle the disputed question.

Dr. Foster considers glycogen to be a reserve fund of carbohydrate material, as will be seen from the following quotation:—

> "If, however, we admit that the liver is either continually or at intervals reconverting its glycogen into sugar, we are led to the conclusion that the hepatic glycogen is in fact a reserve store of carbohydrate material. And we can accept this conclusion without being able to say definitely what becomes of the sugar thus thrown into the portal blood. We have already (page 247) urged the difficulties which are occasioned by the view that sugar is oxidized in the blood, since we have no proof that the blood can oxidize sugar. Such evidence as we have has the contrary tendency. We may, indeed, suppose that the sugar is converted into lactic acid, and that lactates are directly oxidized in the blood; but we have no positive proof that any such oxidation does or can take place. On the other hand, there are theoretical reasons supporting the view that a certain average

composition is necessary for that great internal medium, the blood, in order that the several tissues may thrive upon it to the best advantage; one element of that composition being a certain percentage of sugar. We may suppose that all or several of the tissues are continually drawing upon the blood for sugar, and that hence a certain supply must be kept up to meet this demand; we may imagine, for instance, that muscle is continually, or from time to time needing sugar to build up the contractile material. Hence, when sugar is present in the blood beyond what is needed, the excess is cast out of the body by the kidneys, except that which, passing by the portal vein, becomes converted into glycogen; and, as a matter of fact, we know that more sugar can be injected into the portal than into the jugular vein before it reappears in the urine. When, again, the sugar in the blood is deficient, the lack is at once supplied by a conversion of the hepatic glycogen. Moreover, this view that the glycogen of the liver is a reserve fund of carbohydrate material, is strongly supported by the analogy of the migration of starch in the vegetable kingdom."

This division of the book closes with an account of the "Income and Expenditure of Energy in the Body." Although we are subsequently asked to guard ourselves against adopting the extreme opinion that a muscle is simply a machine for getting work out of the oxidation of non-nitrogenous food, we are here told that "broadly speaking, the animal body is a machine for converting potential into actual energy. The potential energy is supplied by food; this the metabolism of the body converts into the actual energy of heat and mechanical labour."

Dr. Foster accepts the modern doctrine of the force-producing power of the several classes of foods. The discrepancy which exists between the experimental researches of various observers (Voit, Smith, Parkes, etc.) and those of Flint, made on the pedestrian Weston, to ascertain the effect of muscular labour upon the nitrogenous excreta, is said in the text to be "at present inexplicable." Such a statement reads strangely in the face of the careful experiments of his fellow-countryman—the distinguished physiologist of Guy's Hospital—made upon the same pedestrian. Dr. Pavy's experiments were published in the *London Lancet* for last year, and seem to us to point out very fully the fallacy in Prof. Flint's conclusions. Singularly, the name of Dr. Pavy is not mentioned in connection with the subject.

Book III. treats of "The Central Nervous System and its Instruments." This important subject is compressed into one hundred and twenty-two pages, more than half of which (sixty-four pages) is taken up with the special senses. In the space allotted to the discussion, the author has succeeded in presenting the salient points of this intricate department of physiology exceedingly well; but the subject is too immense, and its practical importance too great, to be condensed within such narrow limits without slighting some of its divisions. For instance, less than three pages suffice to dispose of the cranial nerves. There is, however, one compensating feature which we must not overlook, *i. e.*, the very thorough manner in which Dr. Foster has described the influence of the nervous system over the function of each organ and tissue discussed in the body of the work.

We are compelled to restrict ourselves to a single quotation, reflecting the author's opinion upon the presence of localized centres in the cerebral convolutions. The experiments of Hitzig and Fritsch first directed attention to this question, which is now being pursued with so much enthusiasm by our experimental physiologists.

"These experiments (Hitzig, Fritsch, and Ferrier) leave no doubt that there is a connection between galvanic stimulation of the brain-surface and bodily movements; but the exact nature of this connection is at present very obscure. One thing may be at least affirmed, that these cerebral spots are not motor centres in the sense that the co-ordination of the movements takes place in them; for we have seen that the most complete co-ordination obtains in the total absence of the cerebral hemispheres. If there is any real connection between the movements and the gray matter of the convolutions, it must be because the latter has direct relations with the co-ordinating mechanisms placed lower down in the brain. It seems *à priori* unlikely that such valuable material as we must needs suppose the gray matter of the convolutions to be, should be taken up in such, so to speak, menial work as bending or straightening a limb; and the results of subsequent observers have largely diminished the value which was at first attached to Hitzig's observations."

Dr. Foster endeavours to substantiate the above conclusion by a running account of the recent researches of Hermann, Sanderson, Nothnagel, Carville and Duret, and Goltz. He considers the recent observation of Goltz on dogs, to offer most serious objections to the theory of superficial cerebral centres, in any of the forms in which it has as yet been brought forward. These experiments were published in *Pflüger's Archiv*, xiii. (1876), and form one of the most valuable of the recent contributions to cerebral physiology.

We have, perhaps, already sufficiently alluded to the unsatisfactory treatment of "The Tissues and Mechanism of Reproduction," which form the subject-matter of the fourth Book. Under the circumstances, we think the student had a right to expect a fuller exposition of this important branch of physiology from Dr. Foster.

An appendix of fifty-three pages, presenting the chemical features of the more important constituents of the organism, closes the volume.

In conclusion, we can only repeat that Dr. Foster has presented the profession with a text-book on physiology both pleasant in style and trustworthy in exposition. While, in our opinion, in the interest of the student it could be improved in certain directions, some of which have been pointed out in the body of this review, we can confidently recommend it as a faithful exponent of the fundamental principles of that science which underlies all rational medicine. W. J. C.

ART. XXI.—*Clinical Lectures on Diseases of the Heart and Aorta.* By GEO. WILLIAM BALFOUR, M.D., St. And., F.R.C.P. Ed., Physician to, and Lecturer on Medicine in, the Royal Infirmary, Edinburgh. 8vo. pp. xvi., 428. London: J. & A. Churchill, 1876.

"OF making books there is no end," and it were but a simple matter for one who holds a smooth pen, and has a happy knack at construction, to build a new book, at short notice, on any medical subject, with the timbers of other men's hewing. Probably there are too many such books. Possibly they bring patients to the compilers, who, by attaching their own names to stolen wares, advertise themselves. Let us hope not; but, in view of the many compilations which empty the purse and lumber the shelf, it is refreshing to read Balfour's Lectures. At the very outset the book bears the stamp of originality, and the reader soon assures himself that Balfour is a thinker and a worker, and that he has written down